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Promising Pedagogical Practices for Emergent Bilinguals in Kindergarten: Towards a Mathematics Discourse Community

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Promising Pedagogical Practices for Emergent Bilinguals in Kindergarten: Towards a Mathematics Discourse Community

Cover Page Footnote

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Promising Pedagogical Practices for Emergent Bilinguals in Kindergarten: Towards a Mathematics Discourse Community

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In the current U.S. context, it is relevant to disseminate research that portrays in detail how bilingual teachers create challenging and safe mathematics learning environments for emergent bilinguals. It is critical to identify pedagogical approaches that foster emergent bilinguals' participation in mathematics conversations and discourse practices where language is considered a pedagogical resource. This is possible when teachers understand that young Latino/a students come to school with a wide range of cognitive and linguistic tools, which they can use to help them make sense of problems posed in the classroom. Using case study methodology, we define and provide a detailed portrayal of a bilingual kindergarten teacher's mathematics pedagogical practices. Specifically we discuss: (a) the use of authentic *mathematics stories*, (b) the integration of multimodal representation of problem solving, and (c) collective thinking and representation of problem solving solutions. In addition, we analyze how the teacher fosters practices that use language as a learning resource. Finally, we argue that these practices promote a mathematics discourse community and that pedagogy of confidence, care, and understanding is at the core of this teacher's instructional approach.

Keywords: bilingual education, language learners, mathematics pedagogical practices, mathematics discourse community

Ms. Elba's¹ kindergartners knew that most Wednesdays were math story day. This Wednesday was not an exception. It was one bright October morning in a city in New Mexico, and students in this dual language classroom were sitting on the carpet. While students listened attentively, Ms. Elba told them the first mathematics story. "Ms. Sandra tenía seis dulces y Ms. Mary se comió cuatro, ¿cuántos le quedaron a Ms. Sandra?" [Ms. Sandra had six candies and Ms. Mary ate four. How many candies did Ms. Sandra have left?] Ms. Sandra and Ms. Mary were the researchers present that day, observing and recording the classroom interaction.

Ms. Elba usually retold the story. While retelling the story, she used her voice and gestures to emphasize how Ms. Mary dares to eat four

candies. Several students were smiling and raising their hands. Some students said two, some three. Ms. Elba asked who wants to explain how they solved it: “¿Quién me quiere explicar cómo lo hizo? Porque algunos dicen dos, otros dicen tres.” [Who wants to explain how you did it? Because some are saying two and others say three]. More hands were up.

All students in this group could be defined as emergent bilinguals. They communicate and function in their native language as they are acquiring English as their new language (García & Kleifgen, 2010). This group of students was part of a dual language bilingual school where bilingualism was fostered and valued. Moreover, this teacher had been working for over three years on integrating Cognitively Guided Instruction (Carpenter, Fennema, Franke, Levi, & Empson, 1999), into her curriculum because she felt the need to enhance students’ learning opportunities for challenging mathematics and problem solving. Cognitively Guided Instruction is a framework for understanding students’ mathematical thinking that includes a range of word problems students can solve using their own strategies. Word problems included addition, subtraction, multiplication, division, and comparison.

All students were actively engaged during this mathematics activity, most raising their hands showing their eagerness to explain to their peers how they reached the solution they thought as valid. In expanding this example and others, we will show how Ms. Elba’s students were able to solve cognitively and linguistically demanding mathematical problems and explain their thinking in their native language and later on in English. The research questions guiding our qualitative inquiry were: (1) What mathematics pedagogical practices support a classroom discourse community?; (2) How do the mathematics pedagogical practices relate to this teacher’s understanding of mathematics bilingual education? The purpose of this research was to explore these questions in Ms. Elba’s approach to teaching mathematics, identifying what specific pedagogical practices she implemented in her classroom, and how these practices can be interpreted in light of what research has defined as discourse community and mathematics discourse community (Gee, 2009; Moschkovich, 2007; Willey, 2013).

In the current U.S. context, it is relevant to disseminate research that portrays in detail how bilingual teachers create challenging and effective mathematics learning communities that affirm emergent bilinguals’ cultures and languages (Celedón-Pattichis & Ramírez, 2012). The Latino/a population is the fastest growing ethnic group in the United States. It has rapidly increased in the past decade and is expected to continue its growth (Ennis, Ríos-Vargas, & Albert, 2011). The Migration Policy Institute reported that in 2010, 66 % percent of the bilingual learners were Spanish speakers (Pandya, Batalova, & McHugh, 2011). Data on Latino/a youth language proficiency shows that 41% are bilingual, 36% are English dominant, and 23% Spanish dominant (Flores, Hernández-Sheets, & Riojas, 2011).

Although there has been a sustained increase in the Latino/a population, there are educational policies that have negatively impacted their educational achievement and the availability of bilingual education. As a result of state and federal policies like No Child Left Behind (NCLB), bilingual programs have been reduced or in some states,

such as Arizona, California, and Massachusetts, even completely banned (Baker, 2011). Even though these policies have affected other states, the context of this study is still supportive of bilingual education. Particularly, New Mexico recently approved a Bilingual Seal, which students can obtain by completing part of their high school diploma in Spanish.

Overall, the achievement gap in the US among ethnic groups and between English learners and non-English learners has increased (Gándara & Contreras, 2009; Razfar, 2012) over the past decade. For instance, Latino/a kindergartners were one of the ethnic groups found to obtain the lowest scores in an early reading and mathematics skills test applied to a national sample (West, Denton, & Germino-Hausken, 2000). Clements and Sarama (2007) argue about the importance of early mathematics instructional experiences to improve mathematics achievement. There is broad consensus that more needs to be done to develop equitable and quality mathematics instruction to meet the learning needs of emergent bilinguals (Foote, 2010; García & Kleifgen, 2010) to narrow the persistent mathematics achievement gap. Equitable mathematics instruction for emergent bilinguals requires embracing bilingualism as an asset instead of a deficit and understanding these are the students who become bilingual as they learn English.

In this article, we draw from research that discusses how to foster emergent bilinguals' participation in mathematics conversations (Celedón-Pattichis, & Ramírez, 2012) and discourse practices where language is considered a pedagogical resource (Moschkovich, 2007, 2012). Specifically, the case study discussed here is grounded in the literature that argues that young Latino/a students come to school with a wide range of cognitive and linguistic tools, which teachers can use to help them make sense of problems posed in the classroom (Cummins, 2007; Moschkovich, 2007).

In our analysis, we define and provide a detailed portrayal of the different mathematics pedagogical practices identified during classroom observations, video recorded lessons, and teacher interviews. We identify elements of a discourse community, and we extend the work on mathematics discourse community by analyzing specific practices corresponding to a bilingual kindergarten classroom. Finally, we discuss confidence and understanding as the underlying elements of this teacher's pedagogical approach. Drawing from Jackson's (2011) definition of Pedagogy of Confidence and Noddings' (2002) ethics of care, we argue that emergent bilingual students need teachers who care to operate from a framework where confidence and understanding are the pillars for redefining a bilingual classroom teaching approach focused on building a mathematics discourse community.

Conceptual Framework

A Sociocultural Understanding of Mathematics Pedagogical Practice

Our understanding of mathematics teaching and learning draws from sociocultural theory. Building on the work of Vygotsky (1978), we concur that this perspective prioritizes the culturally and socially situated dimension of learning and development (Rogoff, Baker-Sennet, Lacasa, & Goldsmith, 1995; Wenger, 1998). We also understand that learning is in part achieved through active and meaningful

participation in a set of cultural practices, for instance, pedagogical practices for mathematics learning.

Practice within the teaching arena has been used interchangeably with *teaching*, *teaching experience*, and *teacher actions*. Usually, these terms mean what teachers do in order to teach or to create teachable moments. Pedagogical practice in the context of this study refers to action in a social context, the integral body of teachers' and students' daily experiences, and actions related to teaching and learning a specific content within the school environment (Musanti, Marshall, Ceballos, & Celedón-Pattichis, 2011). Freire (1994) defines *pedagogical practice* as a necessary dimension of the social practice. A pedagogical practice always involves the presence of teacher and learner, knowledge to be learned and to be taught, some sort of directionality or vision that makes pedagogical practice not a neutral act but an ethical, cultural, social and political one. We contend that mathematics pedagogical practices are co-constructed by teacher and students and established within a classroom community, involving social situations in which students participate and learn. From this perspective, students, and not only the teacher, are actively involved in the enactment of such practices that constitute the local context of students' mathematical understanding and development (Cobb & Yackel, 1996). From a cultural-historical perspective, pedagogical practices can be understood as cultural practices and routines in which children participate and the ways their participation is supported by other members of the community (Rogoff, 2003). Pedagogical practices in the social context of the classroom involve different types of interactions in which children participate and which mediate their thinking and learning (Vygotsky, 1978). All members within a learning community position themselves and others as participants in myriad ways, but primarily through the use of multiple semiotic tools such as verbal and non-verbal language that mediate their interactions (Empson, 2003; Moschkovich, 2007).

Language, Mathematics Discourse, and Academic Literacy

We build on the work of Khisty and Chval (2002) on the importance to consider the nature of teacher discourse and pedagogical practices when exploring the mathematics learning of Latino/a students. From this perspective, language and discourse are at the core of the social milieu in which teaching and learning take place. Following Moschkovich's work (2007, 2012), language can be conceptualized as a socio-cultural-historical activity and as a pedagogical resource in the context of the classroom. The language of mathematics is not "a list of vocabulary or technical words with precise meanings but the communicative competence necessary and sufficient for competent participation in mathematical discourse practices" (Moschkovich, 2012, p. 17).

The Common Core State Standards (CCSSI, 2010) and the current reform movement in mathematics education emphasize the role that classroom discourse and developing academic literacy play in supporting students' mathematical conceptual development. Developing students' competence to effectively participate in mathematics discussion and communicate mathematically requires more than students learning vocabulary. Communicating mathematically requires that students learn to describe patterns, make generalizations, and use representations to support their

claims. Moreover, when learning mathematics, students need to read, write, speak, listen, and represent their mathematical solutions using drawings, symbols, gestures, or other tools.

These practices require teachers who understand how to identify the mathematics language demands for emergent bilinguals (Civil & Turner, 2014; Moschkovich, 2012). For instance, Carpenter, Franke, and Levi (2003) argued that learning mathematics presupposes students actively engage in meaningful discussion and argumentation. Cobb, Boufi, McClain, and Whitenack (1997) discussed the characteristics of collective reflection that support the active participation of children in class discussions that ultimately foster mathematical understanding. Researchers have argued that creating this type of learning community in the classroom fosters the development of mathematics discourse. Developing such a community involves making mathematical meaning in a social context (Celedón-Pattichis & Musanti, 2013). This requires having interactions between the teacher and students and between students and their peers with an emphasis on mathematical discourse.

Drawing from Wenger's work (1998) on communities of practice and Gee's (2004) on discourse, Willey (2013) contends that a mathematics discourse community is a concept that allows capturing the unique ways of being, doing, thinking, and speaking as they manifest through teachers' and students' interactions in a mathematics classroom. The role of teachers in creating this type of learning environment is critical for emergent bilinguals. Teaching to foster a mathematics discourse community (MDC) requires a learning environment aimed at getting students to see themselves as effective mathematics problem solvers who can formally and informally communicate to others their mathematical thinking, explain, and justify their solutions (Empson, 2003).

Moreover, Franke, Kazemi, and Battey (2007) explain that the way students interact in classrooms and perceive themselves affect their mathematical understanding and "their own sense of their ability to do and persist with mathematics, the way they are viewed as competent in mathematics, and their ability to perform successfully in school" (p. 226). Teaching mathematics to emergent bilinguals entails rich and challenging learning environments. Specifically, these practices draw from different resources and ways to communicate thinking such as the use of manipulatives, drawings, gestures, symbols, and oral communication in students' first and second languages. Storytelling has been recently defined as a practice with an enormous potential to support meaning making in mathematics, especially because mathematics is commonly perceived as the abstract use of symbols, signs, and numbers disconnected from children's lives (Zazkis & Liljedahl, 2009). In recent studies, teachers used stories as natural conversations to pose mathematics word problems. The stories also facilitated mathematical thinking by providing contextual clues and making problem solving meaningful to students by using students' names, friends' or relatives' names, and by drawing from familiar contexts such as school or community events (Celedón-Pattichis & Turner, 2012; Turner, Celedón-Pattichis, Marshall, & Tennison, 2009). Stories always involved some type of conflict or problem that needed to be solved and, in the case of mathematics storytelling, stories included the mathematization of some elements. Teachers need to design instruction that goes beyond developing academic

language, usually reduced to increased vocabulary, and understand the importance of creating practices that promote academic literacy in the context of a discourse community.

Learning academic literacy occurs when teachers create interactional spaces where students participate in varied ways of *doing mathematics* and share new knowledge through multiple ways of representation (Schleppegrell, 2010). Therefore, the importance of caring and understanding emergent bilinguals consists of viewing them as active participants who talk mathematics in the classroom and whose meaningful interactions are mediated by language and promoted by practices derived from in-depth understanding of students' learning needs, language resources, and cultural background.

A Pedagogy of Confidence and Understanding for Students' Mathematical Learning

Research has demonstrated that caring teachers are essential along with a meaningful and challenging curriculum, particularly in fostering the academic success of minority students (Hackenberg, 2005; Noddings, 2002). Recently, Jackson (2011) proposed a Pedagogy of Confidence that she defines as "based on the transformative belief that within all of us resides an untapped reservoir of potential to achieve high levels" (p. 13). This line of research serves to envision the impact of a pedagogy that moves away from the pervasive misconception of emergent bilinguals from a deficit view towards teaching that gives access to challenging curricula, rich classroom discourse, and that fosters social interactions affirming students' identity (Cummins, 2000; García & Kleifgen, 2010). Hackenberg (2005) characterized mathematical caring relations as both inseparable and essential for learning. Teachers are needed who care about mathematics learning but mostly who care about creating a learning environment with certain cognitive and affective conditions. At the same time, teachers who care have confidence in students and they provide new possibilities for students' mathematical thinking, they sustain high expectations for learning, and focus on building students' identity as mathematics learners individually and collectively. Ortiz and Fránquiz (2012) argue that teachers who enact an ethic of care (Noddings, 2002) are those who communicate their high expectations for learning outcomes to students and families. "They build safe learning communities that allow students to take risks without a fear of failure, and they work diligently to assure that students achieve rigorous academic standards" (Ortiz & Fránquiz, 2012, p. 2). We contend that to improve Latino/a emergent bilinguals' mathematical achievement, teachers are needed who enact and commit to a pedagogy of care, rooted in understanding of students' learning needs and committed to high expectations for students' academic achievement in both languages (not only on transitioning them to English) (Gándara & Contreras, 2009).

Researchers have documented what types of understandings teachers need in order to better support emergent bilinguals to master the discourse of mathematics (Khisty & Chval, 2002). As teachers play a central role in the communication process that takes place in the classroom, they need to know how to create an effective classroom environment where mathematics talk builds on students' everyday language

and experiences, integrating informal language use to build academic language, and generating interactions that foster making judgments about mathematical terms (Schleppegrell, 2010). This entails comprehending that language is more than talk and not ignoring “issues of how students become literate in the mathematical discourse, and how the teacher’s own pedagogic discourse influences the process” (Khisty & Chval, 2002, p. 20).

Description of the Study

This case study is part of a longitudinal professional development and qualitative research project conducted in a bilingual education school in a major city in New Mexico. Participants were seven K-4th grade bilingual teachers and 140 students over a period of four years. The longitudinal study involved multiple data sources (digital video recording of mathematics lessons, interviews with teachers, review of student work, among others), was conducted by a team of three researchers, and entailed a close collaboration with each participating teacher individually and as a group. Members of the research team spent a full morning every Wednesday for four years in the school engaging in a situated approach to professional development (See Celedón-Pattichis, Musanti, & Marshall, 2010; Musanti et al., 2011). This approach involved participation in classroom activities co-planned with the teacher, engagement in small group work with students, involvement in debriefing conversations after class to revisit the impact of each lesson, and collaboration in other related activities such as the development of a Parents’ Workshop on the importance of mathematics problem solving.

The selected case, discussed in this article, focused on one kindergarten classroom of 21 students during the school year of 2007-2008. We contend that Ms. Elba’s classroom and teaching constitute *an image of the possible* (Borko, 2004), that is, a valuable representation of a mathematics discourse community (Dyson & Genishi, 2005). Ms. Elba was an experienced certified bilingual teacher who spoke Spanish as her first language. Originally from a Spanish-speaking country in Central America, she held a bachelor’s degree in mathematics education and a master’s degree in bilingual education. She taught kindergarten for over 12 years, participated in a series of professional development experiences on Cognitively Guided Instruction and the integration of language, culture, and mathematics, and at the time of the study she had implemented this approach in her classroom for about three years.

The students in this classroom were mainly Mexican immigrants from low income working families. According to school data, more than 90% of students received free or reduced price meals. Over 90% of the students in the classroom were native Spanish speakers. Ms. Elba described her class:

I have nineteen Spanish dominant students and two English dominant students. From the nineteen that are Spanish-dominant, three of them are pretty bilingual. So that leaves me with sixteen Spanish dominant students, so that means that they are English language learners. Most of them qualify for free lunch and also they are from a low socio-economic background. The parents are very dedicated and very involved in their education. Most of them come from Mexico because

they really want their kids to have a better future than the one they had. And they value education. (Ms. Elba, personal interview, November 7, 2007)

At the time of the study, the school implemented a one-way dual language program tailored for this population in which Spanish instruction at the beginning of the academic year involved 70% of the time (mornings and part of the afternoons) and English approximately 30% (Ms. Elba, personal interview, November 7, 2007). Then in January, the percentage of distributed time for each language was 50% Spanish in the mornings and 50% English in the afternoons. The teacher made this decision based on her assessment of students' needs and readiness to engage in more prolonged English learning time.

Ms. Elba was a seasoned kindergarten teacher. Her passion for teaching was contagious and shaped the way she organized her classroom, her daily routines, and her lessons. Each morning all students worked in Spanish reading, writing, and mathematics activities. During the afternoon, students participated in integrated projects and additional literacy related tasks in English. During the last year of our research we visited her classroom on a monthly basis and digitally video recorded six sessions conducted in October, November, February, March, April, and May. She also participated in monthly workshops organized for the school teachers and facilitated by the research team. During these workshops we discussed different topics related to children's mathematical understanding in relation to issues of language and the specific instructional approaches that could improve students' understanding of complex mathematical concepts and problem solving. She was one of the teachers who joined the researchers in a final presentation at a state conference on bilingual education. We triangulated our analysis of video recorded classroom sessions with data from two in-depth interviews that explored the teacher's beliefs about bilingual education and her approach to integrating CGI into her kindergarten curriculum. During these interviews, we also focused on her understanding of students' learning needs in terms of language development as well as mathematics content (Marshall & Rossman, 2011).

We understand data analysis as an inductive and reflexive process (Dyson & Genishi, 2005). Initially, while collecting the data, we took notes on our insights and identified aspects of classroom interaction meaningful to our research questions. We compared and contrasted our notes and video recorded lessons through multiple viewings, created content logs of videos, identified and transcribed meaningful video segments, and coded those segments that signaled moments that responded to our definition of mathematics pedagogical practices typical of this classroom. We also coded the interview data to identify when the teacher referred to her teaching rationale, her bilingual education beliefs, and specific descriptions of how she implemented CGI in her classroom. We reorganized and collapsed the results of the open coding into more focused categories that resulted in the identification of salient mathematics pedagogical practices: the mathematics story, multimodal representation and collective reflection/thinking/writing. In relation to these practices, we identified moments that show evidence of caring about students, high expectations, and understanding students' needs.

Results

Ms. Elba's mathematics instruction was in Spanish and focused on providing a rich curriculum for her students. She clearly voiced her teaching philosophy regarding bilingual education and mathematics instruction. This is important as it formed the basis of her decision making regarding what pedagogical moves benefited her students.

I have read a lot of articles as a bilingual teacher and I have noted that a lot of the education of Latino students is really based a lot on skills because they think that they are not as smart as other ethnicities. But CGI proves that these kids can solve problems, since they are younger and it really, really overrates the false belief that Latino kids should be making more drills and less problem solving. (Ms. Elba, personal interview, May 12, 2008)

The analysis of classroom observations and video recordings of classrooms sessions as well as the interviews showed several important characteristics in Ms. Elba's instructional approach and the mathematical practices she prioritized. Specifically, three mathematics pedagogical practices were used consistently in her instruction: (a) the use of authentic *mathematics stories*, (b) the integration of multimodal representation of problem solving, and (c) collective thinking and representation of problem solving solutions. We argue that these mathematics pedagogical practices are integral to the way Ms. Elba taught mathematics to her kindergarten classroom and represent of her beliefs about mathematics learning and the role of language as a pedagogical resource. It is important to notice that these practices did not appear separate from each other but were interwoven, constituting what we defined above as a mathematics discourse community. For instance, the way she integrated multimodal representation of problem solutions is evident both through our discussion of use of authentic mathematics stories and the collective dimension of learning that she emphasized in her lesson designs. Therefore, we present our findings integrating these practices to capture the complexity and nuances of the pedagogical approach. Lastly, we show how these students were able to think and solve the same type of stories when the stories were introduced in English by the end of the school year as an example of the enactment of the pedagogy of care, confidence, and understanding that this teacher displayed consistently in her instructional approach.

Using Authentic Mathematics Stories and Challenging Mathematics

The narrative structure of the mathematics stories² scaffolds students' thinking and explanations. The structure of a mathematics story consists of using a familiar context including a simple action or relationship involving numbers. Problems that reflect familiar contexts invite students to draw upon lived experiences to make sense of mathematical ideas (Turner et al., 2009). For example, the word problem "Antonia has seven apples. Her mother gives her two more. How many apples does Antonia have in total?" involves a familiar context which teachers can use to scaffold students' thinking. The story includes an action (i.e., gives) that defines two sets of objects and helps students to establish the relationship between the numbers, and it provides opportunities for students to use different strategies to solve the problem.

Ms. Elba presented mathematics stories because she believed that problems in the form of stories help students learn to represent mathematical ideas and connect multiple representations (e.g., drawings, symbols, objects). Moreover, her lessons demonstrated the impact of using storytelling on scaffolding the understanding of complex mathematical concepts, such as division problems, while fostering the development of literacy and academic language in their first language. The mathematics stories provided a context for emergent bilinguals to draw upon to make sense of mathematics and language.

A typical lesson involved an initial moment where the whole class thought about and solved a mathematics story presented by Ms. Elba. The teacher presented the story, provided time for students to think about it, and then asked one or two students to share their solutions, either orally or in writing, on the board. Regularly, the whole group work was followed by small group work using manipulatives or white boards to solve the problems. Ms. Elba usually worked with the students who needed more support in terms of mathematical content. Each group worked with an adult who scaffolded the process, usually the teacher or one of the two educational assistants available. Ms. Elba or the educational assistant posed a word problem; students worked on a solution and then demonstrated how they solved it.

Characters and scenes in mathematics stories were typically drawn from the context of the classroom, involving students or other adults present at the time, such as the researchers. For instance, during the video recorded lesson in February, Ms. Elba posed this problem while students worked in small groups:

Ms. Elba: Escuchen primero toda la historia . . . *Ms. Analía hizo 8 galletas y las quería repartir entre Ms. Sandra [researcher] y Ms. Elba y no quería que nos peleáramos. ¿Cuántas nos toca a cada una?*

Les quiere dar igual a Ms. Sandra y Ms. Elba.

(Listen first to the whole story. . . Ms. Analía cooked eight cookies, and she wanted to distribute them between Ms. Sandra and Ms. Elba. She didn't want us to fight. How many does each of us get? She wants to give the same number to Ms. Sandra and Ms. Elba.)

The example above illustrates how this teacher mathematized familiar situations for students embedding complex mathematical ideas. In this case, this is a partitive division problem that required students to partition a collection into equivalent sets without remainders (Carpenter et al., 1999). Children initially solved this problem by direct modeling the action of creating two sets with the same number of objects, in this story, cookies. In Ms. Elba's table, students worked with their plastic bears to try to solve the problem. Cristina had two sets of four bears. Ms. Elba asked her how she did it. Cristina showed how she used her fingers to figure it out.

Cristina: Yo conté uno, dos [muestra dos dedos de una mano], uno, dos [dos dedos de la otra mano], uno dos [dos dedos en la primera mano] uno dos [dos en la otra mano]

(I counted one, two [shows two fingers in one hand], one, two [two fingers in the other hand], one, two [two in the first hand] one, two [two in the other hand].) [Shows four fingers in each hand.]

Ms. Elba: Y entonces, ¿cuántos nos dio a cada una?
(*and then how many did she give each one?*)

Cristina: cuatro. (*Four*)

Ms. Elba: Ella contó de dos en dos. (*she counted by twos*) [showing to the class]

As illustrated by Ms. Elba's last statement in the above interaction, progressively, she integrated more complex versions of multiplication and division problems. This expectation is above current standards for her grade. Specifically, the CCSS Mathematics (CCSSI, 2010) indicates that addition and subtraction are the expected outcome for the kindergarten grade. This teacher believed students had the capacity to move forward with their mathematics thinking and felt that challenging them would foster their self-perception as capable and confident mathematics learners. She described her pedagogical approach and her emphasis on "honoring" different ways to solve problems while integrating mathematical procedures. In doing so, she built from students' spontaneous strategies, connected visual representation with oral explanations of solutions, and introduced challenging mathematics for students who were still grappling with number sense.

I really structured it, first to make sure that they come with different solutions and to honor different ways of solving a problem. And that's the very first thing I do. And then I structure, too, in the way that they need to do certain procedures that the ones that I want to see visual, you know the visualization needs to be explained. ... They can represent it the way that they want, they can count with two fingers on one [hand] and two on the other one. They can come with all different arrangements for the manipulatives ...And I really, really stress the structure right there. That they need to explain why and they need to explain to me even with the number stories. It is the same amount even if you represent it differently. So they learn that there are different representations for the quantities. And then we go into the problem. And this year I went early. They had just mastered to ten and some kids to five, but we were able to do already a problem solving. I introduced it ahead of time. (Ms. Elba, personal interview, May 12, 2008)

The teaching progression involved moving through different ways to communicate students' thinking, articulating more complex ways to orally express their strategies, using drawings to show their thinking, incorporating mathematics symbols to indicate different operations such as addition and subtraction, and writing mathematics problems and solutions in mathematics journals. Students were consistently encouraged to represent problem solving strategies in different ways: explaining, using direct modeling and drawing, and writing a number sentence (see Figure 1).

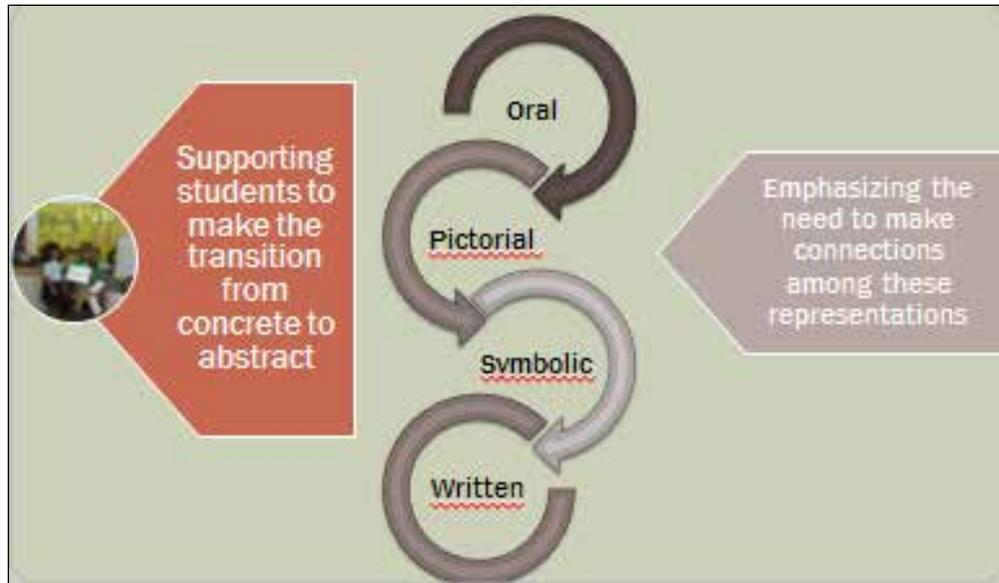


Figure 1. An approach to integrating multimodal representation in mathematics learning

The Collective Dimension of Constructing Problem Solving Strategies

Ms. Elba knew that communicating mathematically could be challenging for young children, particularly children who were in the process of learning the language of instruction. Her lessons provided multiple opportunities for students to listen to peers, to collectively compare strategies, to explain their way to solve or think about a mathematics story, and to analyze their differences. This type of approach prompted a collective construction of meaning and was anchored in Cobb et al.'s work (1997). They define collective reflection as taking place when children participate in reflecting on a communal mathematical discourse practice such as explaining their solution to a problem to peers or actively listening to peers' explanations.

Ms. Elba wanted students to share their thinking, and they were aware that learning to communicate mathematically required access to a variety of practices that they could draw upon. In addition, Ms. Elba generated moments of collective or shared writing while solving a problem or thinking about different solutions.

After posing the problem described in the beginning of this article (Ms. Sandra had six candies. Ms. Mary ate four. How many are left?), Ms. Elba had one student model how she solved it using her fingers and then she asked several students to go the front of the room to draw how they did the problem. To scaffold them in the process of thinking how to create a visual representation of the solution, Ms. Elba used different types of questions. First, she appealed to students to *imagine* through the use of everyday language. For instance, after José drew six circles to represent the initial quantity of candies, Ms. Elba helped him to think how to continue asking questions to scaffold the reconstruction of the story:

Ms. Elba: **Muy bien, ¿y qué pasó? Ms. Mary qué?** (*Very good, and what happened? Ms. Mary what?*)

Juan: Se los comió. (*She ate them.*)

Ms. Elba: Se comió...¿Cuántos? (*She ate...how many?*)

Juan: Cuatro. (*Four.*)

Ms. Elba: O.K., ¿cómo le hizo? (*How did she do it?*) [Juan is staring at his drawing not very sure what to do next] **Cómaselos, miam, miam, miam, miam.** [imitating the act of eating the candies] (*Eat them...miam, miam, miam, miam.*)

As Juan is having trouble figuring out how to show the result of Ms. Mary eating the four candies, Ms. Elba involves the rest of the group, asking them:

Ms. Elba: ¿Cómo nos podríamos comer los dulces en un dibujo? (*How could we eat the candies shown in a drawing?*)

Student: We mixed it up [answering in English].

Ms. Elba: Oh, we mix it up [showing with her hand the act of erasing on the board].

Students: Lo borramos. (*We erase them.*)

Ms. Elba: Ah, lo borramos. (*Ah, we erase them.*) [Then, Juan is able to erase four candies. He counts how many are left and students conclude one more time that the result of Ms. Mary eating the four candies is that there are only two left for Ms. Sandra.]

This interaction shows how Ms. Elba validated students' answers, helped them to move forward in their thinking and to elicit more ways to represent the solution to the problem by imagining different ways to symbolically represent the subtraction. Figure 2 shows the board after different students had drawn an alternative representation.

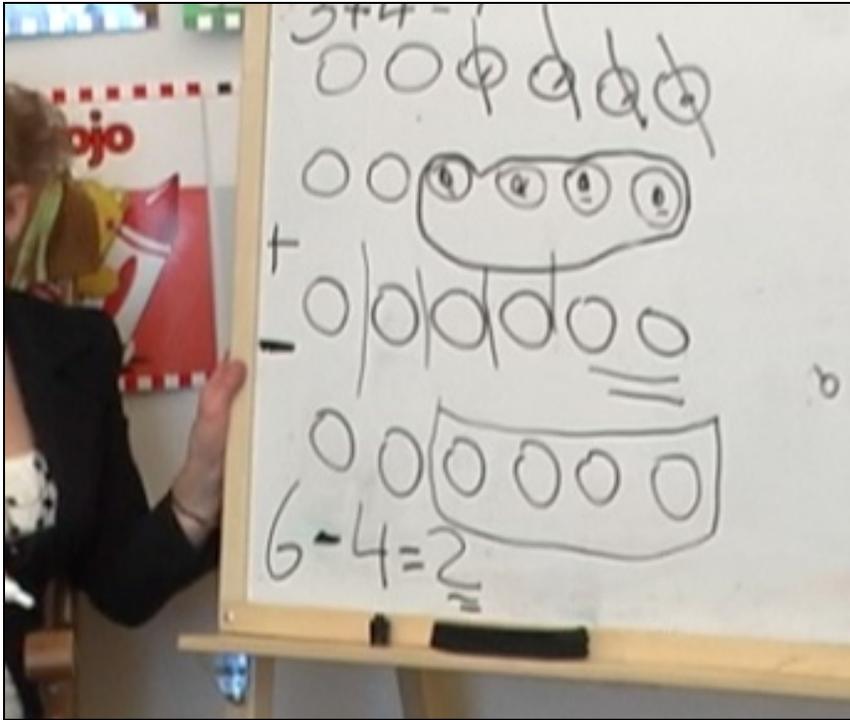


Figure 2. Students share multiple ways to represent the solution to a subtraction problem.

Finally, Ms. Elba shared her own representation, by drawing six circles and then crossing each one with a line. This is an important pedagogical move when the teacher enriches students' representational tools by modeling other mathematical representations. In addition, this collaborative writing of a pictorial representation of a solution is important as a way to reflect about a mathematical problem that strengthens and amplifies students' strategies repertoire. At the end of this activity, Ms. Elba also asked students to come up with a way to represent the solution with numbers. This was harder for students because they were being introduced for the first time to writing numbers and equations that represented the quantities as well as the actions involved in each mathematics story. So, Ms. Elba modeled her thinking aloud while writing down the number sentence: $6 - 4 = 2$.

Fostering Mathematics Understanding and Language Development

Ms. Elba had high expectations for her students in terms of both mathematics understanding and first and second language development, and she designed her instruction accordingly (Ortiz & Fránquiz, 2012). She was aware of how language is connected to mathematics learning. She explained:

Well I use a lot of the language, oral language, during mathematics. But mathematics too are embedded in reading and literacy and writing. And for example we count the letters of their name, how many letters. And then we count the syllables, of the clusters you know. And then we count how many words does the sentence have. Which word is longer, which one is smaller, and

they can tell me how many letters, how many words. So I try to integrate all that into, and I try to integrate literacy too, into the problem solving and math stories. (Ms. Elba, personal interview, November 7, 2007)

During this particular school year, Ms. Elba made the decision to integrate problem solving during English time in the second semester. She believed students were ready and that they were capable of grappling with mathematics stories in English, too. Ms. Elba started the class by posing the following word problem, “In my fish tank I put five fish and then Ms. Craw gave me three more. How many do I have in the fish tank?” She told the students that this was the first time they were to think about a mathematics story in English. The teacher contextualized the story using the fish tank they had in the classroom because it was something very familiar to all students. The teacher asked students to think about the problem and then raise their hand when they **thought** they were ready. Students began to put up one hand to illustrate five fish and three fingers to represent the set of three fish. Ms. Elba’s decision to integrate solving problems during English time was based on her knowledge of how language transfer occurs.

After a student shared and modeled his solution to the problem on the board using drawing and adding a number sentence ($5 + 3 = 8$), Ms. Elba decided to challenge students and asked them to read aloud the number sentence in English for the first time. Her pedagogical move showed how she motivated students to read aloud the number sentence creating a playful situation while communicating her confidence in their second language learners’ abilities to do so and pretending that she did not know how to read the number sentence in English.

- Ms. Elba: Ay! Now boys and girls Ms. Elba does not know how to read this sentence in English.
- Students: Five plus three [one or two students]
- Ms. Elba: Oh, oh, I didn’t know, how are we reading [she is pointing to number 5].
- Students: Five [Ms. Elba says five while pointing to the number.]
- Student: Plus [Ms. Elba is pointing to the plus sign, reads “plus” after the student.]
- Student: Three [Ms. Elba points to the three.]
- [Now, Ms. Elba is pointing to the equal sign and one student says: “same”.]
- Student: Same as eight.
- Ms. Elba: Five plus three same [pointing to each element in the sentence]
- Students: Same like eight.

As the interaction showed, students were able to chorally read it as “Five plus three same as eight” while others read it as “Five plus three same like eight”. The teacher acknowledged all the responses, validating students’ attempts. Then she built on students’ academic vocabulary by appealing to their first language and making an explicit connection to the use of cognates (words that share the same origin, sound, and

look similarly, and sometimes share the same meaning) of “igual” and “equal”. The following interaction highlights these points.

- Ms. Elba: O.K. Can we use another word for same? Same is O.K. Same as eight. That’s O.K. I like it. But we can say five plus three. How do we say it in Spanish? [pointing to the = sign]
- Students: Igual. (*Equal*)
- Ms. Elba: Igual. (*Equal*) So, it’s a very similar word. Five plus three equal...how many?
- Students: Eight.
- Ms. Elba: Eight. Whether you say same it’s O.K., but we are gonna try to use the new word. Let’s...everybody here...Five plus three equal...
- Students: Eight.

This interaction illustrated how students were able to transfer their knowledge about problem solving to English but, more importantly, it showed how Ms. Elba built on the idea that students’ first language is a pedagogical resource for learning (Moschkovich, 2007). The interaction was also an example of how Ms. Elba avoided strictly separating languages during instruction using both languages to scaffold students’ conceptual understanding. By connecting the word “igual” with its cognate “equal,” the teacher validated the students’ home language, Spanish, as a resource, bridged both languages in relation to mathematics problem solving (García & Kleifgen, 2010), and fostered participation in mathematical discourse practices by scaffolding the appropriate way to read the number sentence in English.

Conclusions

In this article we identified the mathematics pedagogical practices Ms. Elba implemented that are conducive to developing a mathematics discourse community in her bilingual classroom. Specifically, we described:

1. How she used mathematics stories to develop problem solving skills and to introduce complex mathematical concepts;
2. How she emphasized a collective dimension of learning through sharing how to solve problems using multiple representational tools (oral explanations, pictorial representations, and mathematical symbols);
3. How she fostered practices that avoid the bracketing of English, “a strict separation of English from instruction in other languages” (García & Kleifgen, 2010, p. 54);
4. How she promoted the use of languages as a learning resource, as shown in the way she connects “igual” with its cognate “equal”.

In addition, our analysis discussed how Ms. Elba’s confidence on emergent bilingual students’ learning capabilities, her care about proposing a challenging mathematics curriculum, and her understanding of students’ mathematical thinking and learning needs were fundamental elements of Ms. Elba’s approach to building a mathematics discourse community.

Ms. Elba's decision making regarding how to approach teaching mathematics in her kindergarten classroom is anchored in her understanding of students' mathematical thinking and her core beliefs regarding emergent bilingual Latino/a students' mathematics education. Ms. Elba showed commitment in addressing the inequities that often exist for Latino/a children, making it a priority to provide more opportunities to solve word problems before they mastered basic skills. She demonstrated this in the way she structured her practice as well as through her rationale. Every week, she presented students with different mathematics stories that challenged students to think and solve different types of mathematics problems including multiplication and division problems. In doing so, she tapped into students' spontaneous problem solving strategies by scaffolding their thinking through the use of manipulatives first, and progressively introducing different types of representation tools, such as drawing, symbols and, more importantly, oral explanation of students' solutions to their problems (Carpenter et al., 1999). Moreover, mathematizing real life type of situations to create a mathematics story was a pedagogical move. For example, the fish tank problem connected mathematics with students' experiences and existing knowledge (Chval & Chávez, 2011/2012).

In agreement with previous studies (i.e., Turner et al., 2009), our analysis shows that these mathematics pedagogical practices contribute to positioning students as effective problem solvers. In the case of Ms. Elba's classroom, this was accomplished by specific teacher pedagogical moves such as validating students' answers, promoting sharing and listening to different strategies to problem solving, even when the result was incorrect, and challenging students with progressively more difficult mathematics problems, including multiplication and division. Students appeared confident, relaxed, very engaged and persistent while attempting to solve difficult mathematics problems.

A major component of developing a mathematics discourse community involved affording students opportunities to hear and use the language needed for learning mathematics, necessary for appropriation (Celedón-Pattichis & Musanti, 2013; Chval & Khisty, 2009) and making students aware of the specific mathematical language needed to perform different mathematical tasks. Participating in a mathematics discourse community requires opportunities for collective reflection and mathematics talk. Ms. Elba consistently staged situations where students shared their thinking and listened to peers explain their stories in either Spanish or English. Her goal was for students to progressively incorporate more accurate ways of explaining their ideas and strategies (Musanti & Celedón-Pattichis, 2012).

Implications for Practice

Implications of this study point to the need to create learning environments that support emergent bilinguals by engaging in a mathematics discourse community with the following characteristics:

- i Design of instruction to support mathematics AND language development: Create classroom environments that are rich in language and mathematics content. This can be achieved by providing students with multiple opportunities to solve challenging mathematics problems and, in addition, by allowing students to create their own mathematics stories. Becoming

- problem posers involves a deeper understanding of the mathematical concepts presented in different types of problems and requires that students establish a mathematical relationship between numbers by embedding them in a specific story.
- j Support of mathematical thinking through language: Using first language as a resource for learning and bridging the languages to support meaning making.
 - j Integration of multimodal ways to represent meaning: Connection of language with mathematical representations (e.g., pictures, symbols, tables, graphs, equations) and encouragement of students to orally explain the different ways they find to solve the problems.
 - j Emphasis on meaning and the multiple meanings of words: Identification of relevant information in the stories, using the information to think about the story and the possible ways to represent a solution.
 - j Collective construction of problem solving strategies and arguments to explain thinking: Creation of a classroom environment that integrates the characteristics of a mathematical discourse community.
 - j Enactment of a pedagogy of confidence and care: Value students' answers and their use of language resources, and position students as mathematics learners by challenging them with progressively more difficult mathematics problems.

Future Research Directions

This study focused on investigating pedagogical practices that support a mathematics discourse community in a kindergarten bilingual (Spanish/English) classroom. Given the current high stakes testing demands beginning in third grade, future research studies can expand on this work to explore how teachers create mathematics discourse communities that afford students opportunities to draw from their linguistic and cultural resources in mainstream classrooms where the teaching of mathematics may not occur in the students' native language. More studies are needed in upper elementary grades that include students who represent multiple languages and cultures; and there is a paucity of studies, particularly in secondary mathematics classrooms, that serve culturally and linguistically diverse students.

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Notes

¹All names and site names are pseudonyms.

²The use of a mathematics story is different from a literary story, which contains many elements. Literary stories typically include several characters, a setting (time and place), a plot and pace, a narrative voice, and a conclusion or ending.

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